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GAMMA RAY ANALYSIS OF THORIATED TUNGSTEN WELDING RODS

Some welding operations, Gas Tungsten Arc (GTA) welding, e.g., use rods of thoriated tungsten as the electrode. A sample of sweepings from an area in IB 3 at which such welding rods were prepared for use by grinding was analyzed for radioactive content with a Ge(Li) detector at the nuclear counting lab. The sweepings, with abnormally high activity, were uncovered in a routine dumpster check.

A portion of the gamma ray spectrum obtained with a high-purity Ge detector is shown in Fig. 1. Some of the peaks associated with the ^{232}Th decay series are clearly observed. The predominant lines are from the decay of ^{228}Ac and represent transitions to the first-excited and ground states in ^{228}Th from nuclear energy levels at 396 (gamma line not shown on Fig. 1) and 969 keV. (See Fig. 2.) The peak near 75 keV represents a Bismuth K x-ray from ^{212}Pb decay in the Th-series.

There is also a peak near 60 keV in Fig. 1, which is much too intense to be associated with the alpha particle decay of ^{232}Th to the 59.5 keV state in ^{228}Ra (see Fig. 2) since such a state is known to have only a 0.15% branching ratio to decay by gamma emission. Although the energy is consistent with that expected for the 59.5 keV gamma transition associated with the decay of ^{241}Am, it is hard to understand such contamination in a normal welding rod, or in a welding shop. Furthermore, there is also (as seen in Fig. 1) an only partially resolved peak near 58 keV and structure at 67 keV, which would not be expected for ^{241}Am.

Two samples of the floor sweepings, and another sample obtained from material found in grooves of a metal table used by the IB 3 welders revealed very similar spectral signatures. All showed the 60 keV peak, as did an analysis of two unused welding rods.

A number of the samples were submitted for further analysis to Argonne National Lab. The partially resolved transitions near 60 keV observed with the Ge(Li) and HpGe detectors were completely resolved with a SiLi detector into two spectral lines - one at 59.3 keV and the other at 58.0 keV. These energies and the observed intensities are consistent with those characteristic of K-shell Tungsten x-rays. The 67 keV line (on Fig. 1) also represents a Tungsten K x-ray. Apparently, electron vacancies in the Tungsten atomic K-shell caused either by electrons or photons that originate in the ^{232}Th decay series permit transitions characteristic of L-to-K-shell and M-to-K-shell energy differences.

In summary, cuttings or grindings from thoriated tungsten welding rods, when submitted for spectral analysis, exhibit not only the known gamma ray transitions expected for the ^{232}Th decay series, but x-rays characteristic of atomic transitions in tungsten as well.

ACKNOWLEDGEMENT

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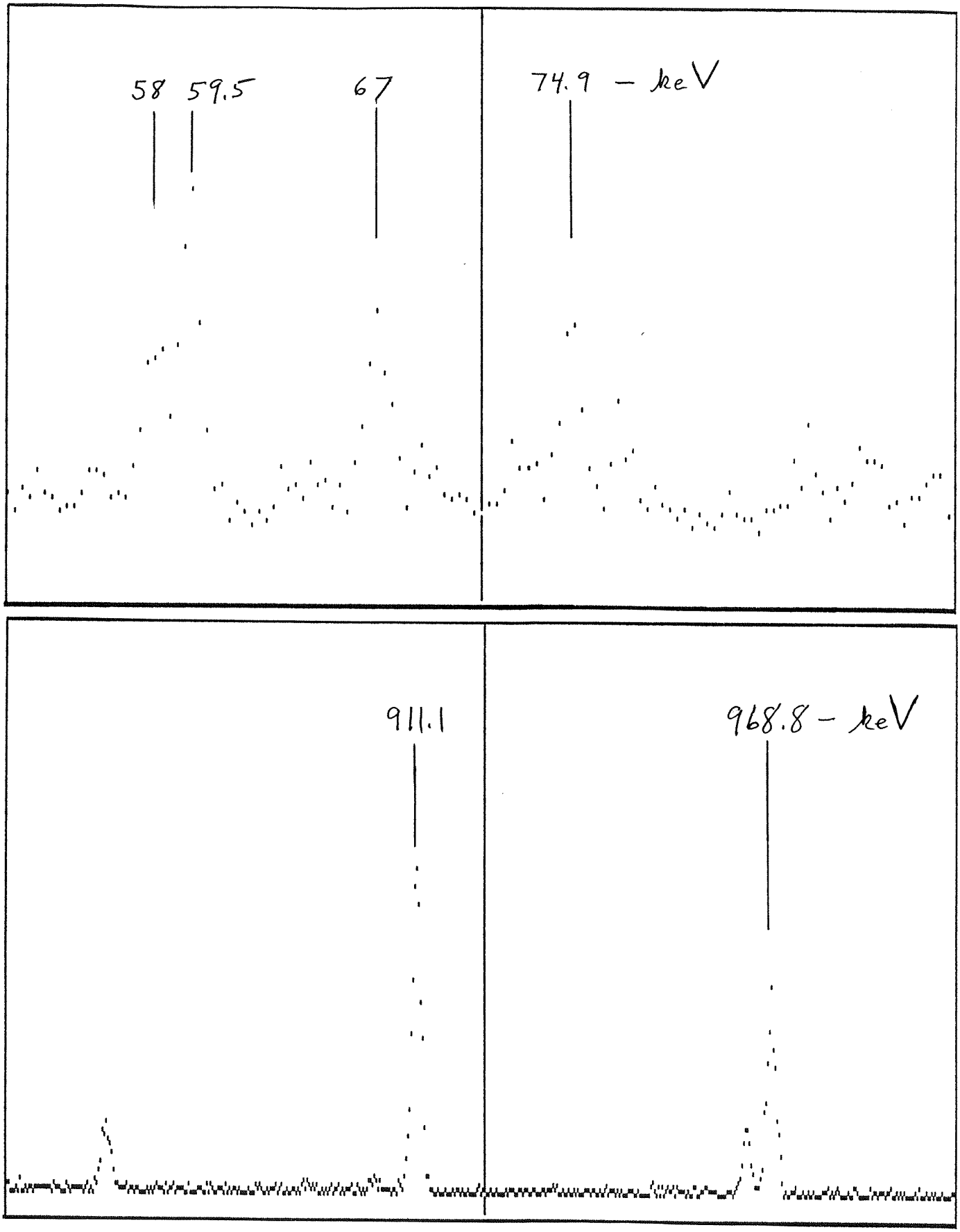
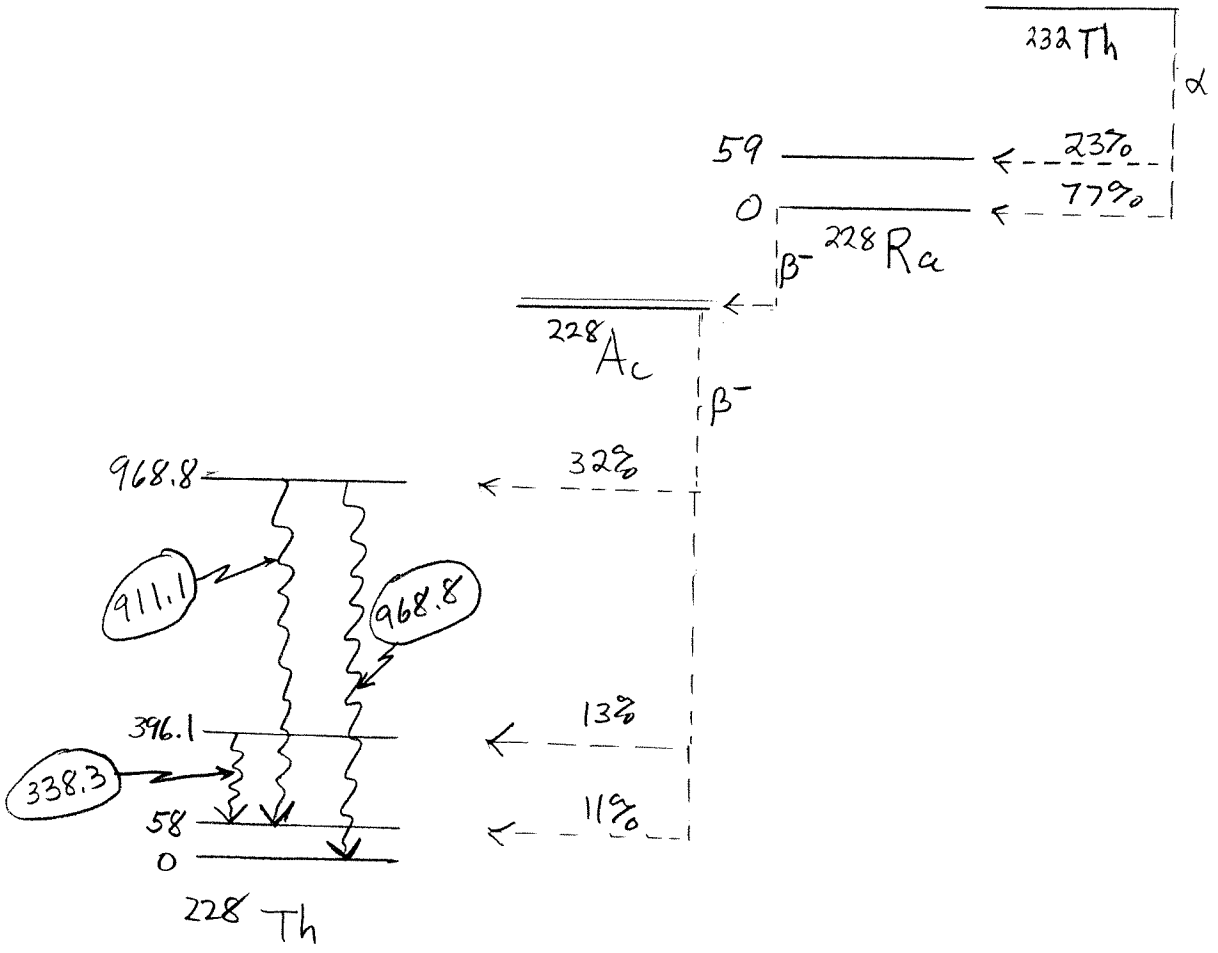


Figure 1



Some of the important nuclear levels involved in the Th-decay-series. Energies in keV. The major ^{228}Ac decay γ-rays are circled.

Figure 2